

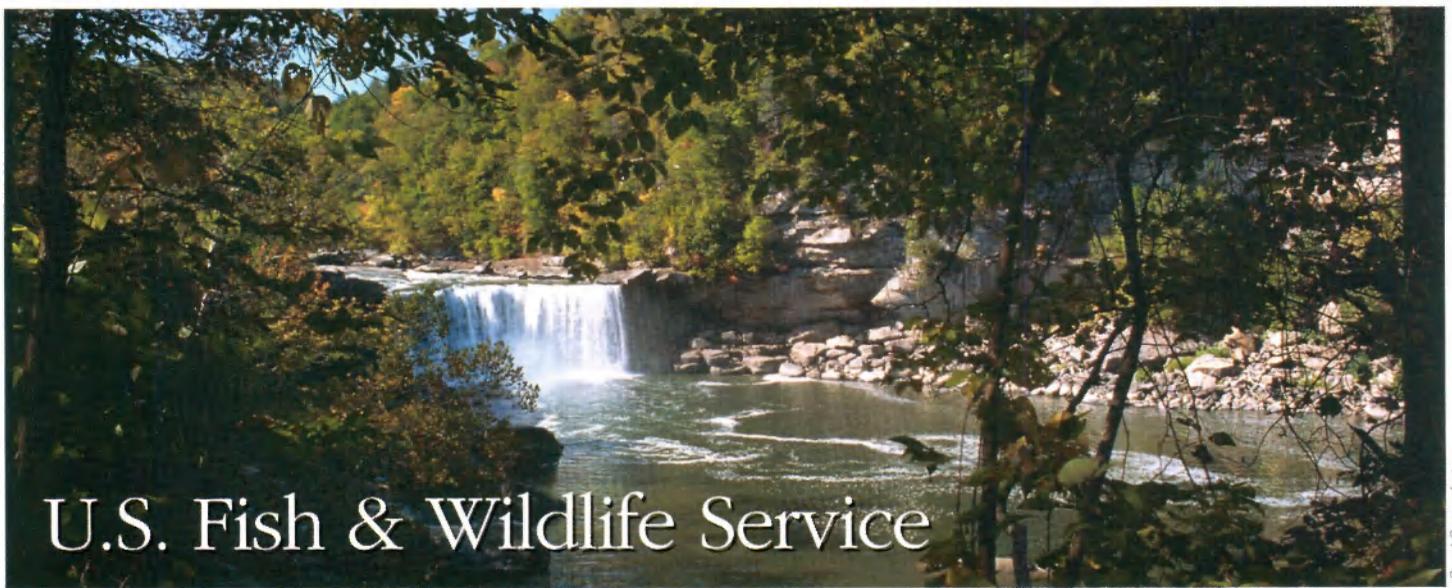
ENDANGERED *Species* BULLETIN

May/June 1999

Vol. XXIV No. 3



Many people think of zoos and aquariums merely as places where wildlife is held for public enjoyment. Today's responsible zoos and aquariums, however, have been transformed from the menageries of ancient times to refugia or "arks" for imperiled species. That transformation continues as more institutions evolve into centers for conservation, research, and education. Another change has been the greater attention given to the amazing variety of wildlife native to North America. These species are not necessarily charismatic and do not always draw crowds, and in many cases the work of recovery goes on behind the scenes. This edition of the Bulletin focuses not only on lesser known species but also on some of the zoos and aquariums whose efforts deserve to be known better



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On the Cover

The American burying beetle, a highly endangered insect, is being bred by the Roger Williams Park Zoo for reintroduction onto Nantucket Island.

Photo © M. Gillis

The Endangered Species Bulletin welcomes manuscripts on a wide range of topics related to endangered species. We are particularly interested in news about recovery, habitat conservation plans, and cooperative ventures. Please contact the Editor before preparing a manuscript. We cannot guarantee publication.

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Partners for Species Recovery

by Jamie Rappaport Clark



**Jamie Rappaport Clark, Director of
the U.S. Fish and Wildlife Service**
USFWS photo

With this issue of the *Endangered Species Bulletin*, I am reminded of the editorial, reprinted on the opposing page, that was written by the American Zoo and Aquarium Association's Executive Director, Syd Butler. His reflections on last year's anniversary of the Endangered Species Act and the future of the Wyoming toad (*Bufo hemiophrys baxteri*) speaks quite directly to the focus of this edition of the *Bulletin*.

The American Zoo and Aquarium Association and its nearly 200 member institutions have been partners in the conservation and recovery of endangered species with the Fish and Wildlife Service for a long time. Some of those partnerships have been extraordinarily critical. They provided the crucial opportunity to turn species such as the California condor (*Gymnogyps californianus*), red wolf (*Canis rufus*), and black-footed ferret (*Mustela nigripes*) from almost certain extinction toward recovery. Though these efforts deserve our highest praise and appreciation, they are, as Syd points out, only part of the story. The whole story includes the efforts to save dozens and dozens of smaller, less well known species that have become imperiled by human activities.

The choice of the Wyoming toad for the cover of the AZA's March 1998 issue of *Communique* pleased me as well. When I look at the list of more than 1,100 species of plants and animals protected by the Endangered Species Act, it is easy to pick out the "popular" species, the ones that most people know. Feathered or furred, they are the stars of many nature documentaries and magazine covers. They often symbolize

such admired qualities as strength, bravery, and speed. The effort to help people understand that toads, freshwater clams, insects, and other animals and plants are also worthy of saving is at times a daunting task.

But then I think about a species such as the Wyoming toad, and the many friends of this amphibian who are helping to save it. I take encouragement from the knowledge that zoos and aquariums are undertaking similar efforts all across this nation for all types of endangered species. As this issue of the *Bulletin* will share with you, zoos and aquariums are not just about so-called "charismatic" animals, nor are they only about creatures from distant exotic lands.

Zoos and aquariums are also on the cutting edge in fields such as conservation education. Through state-of-the-art exhibits, hands-on encounters, distance learning, school programs, and other innovative means, the people who make up this community share their love, enthusiasm, and curiosity about life on this planet with millions of us every year. I extend my thanks and appreciation to the directors, professional staff, technicians, volunteers, and friends of our Nation's zoos and aquariums in their efforts to breed endangered species, conduct research, and rekindle our fascination with the natural world.

*Jamie Rappaport Clark is the Director
of the U.S. Fish and Wildlife Service.*

On the Side of Life

Last year, the Endangered Species Act celebrated its 25th anniversary. Many of its advocates, including the American Zoo and Aquarium Association, took time to celebrate that event and to reflect on the law's past and future. In March 1998, the following piece was published in the AZA's publication Communique by its executive director, Dr. Sydney Butler. We have reprinted it here because it speaks to the AZA's commitment for conserving not just the foreign or exotic species of greatest popularity but to the work for species in our own "backyard."

I am particularly fond of the *Communique* cover photograph this month. In this 25th anniversary year of the Endangered Species Act, when other magazine covers will splendidly display eagles, wolves, and gray whales, we proudly present—the Wyoming toad. Just sitting there, showing its best side to the camera. It doesn't soar, howl, breach (or croak "Bud-wis-er").

But our cover star might tell us that beauty is in the eye of the beholder. To some, this toad would be just another ridiculous thing—in the family of snail darters and spotted owls—that is used by idealists to stop humanity's rightful progress. To others, like nine AZA institutions, the U.S. Fish and Wildlife Service, and lots of committed citizens, this toad is worth every instant of time, effort, and dollars spent to conserve it. One man's toad is another man's prince.

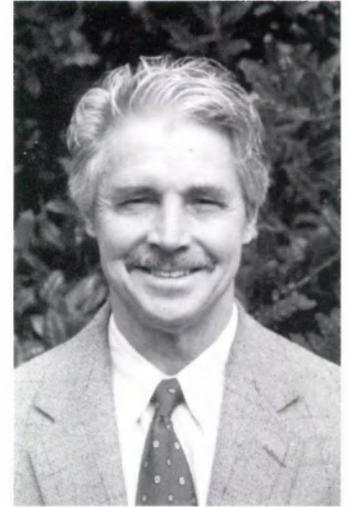
But surely some would say that, in the "grand scheme of things," some lesser creatures have to give way to people. A national symbol like the bald eagle is worth saving, but a *toad*? To that argument our cover creature would say, "Look, I may not be a regal

megavertebrate, but I don't take up much space in the *least populated state in the U.S.* If I am disposable here, what are the prospects for tigers in India, a country with a billion people? In fact, what chance do any creatures have, *including yourselves*, in a world soon to have 8 billion people?"

Just about now I start getting discouraged. A hundred Wyoming toads left in the least populated state? Three thousand tigers left in a country with a billion people? A world filled with 8.2 billion humans by 2030? Just what and who is really endangered here? Toads? Tigers? Ourselves, our children, our grandchildren?

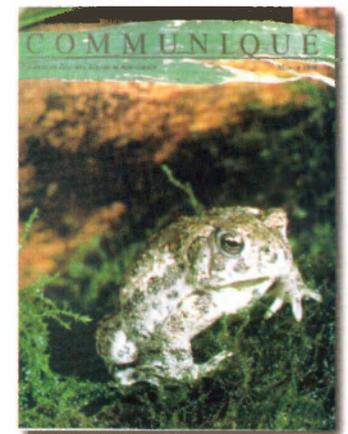
But then I become grateful, really grateful, for the Endangered Species Act. Not so much because of its legal protections, but because of its optimistic, consistent, and clarifying declaration that all species are worthy. Without this declaration, fiercely protected, what is beautiful becomes ugly. Toads become silly, tigers become pests, wolves become pelts, people become enemies. The Act surely recognizes that nature isn't perfect, that balance and compromise are sometimes necessary. But underneath all, it declares that creatures should live because life itself is the overwhelming value.

The Act's declaration for life has remarkable appeal. It drives zoos and aquarium professionals to keep studying and reintroducing Wyoming toads, even when they know that few may survive. And it inspires us by saying we could put any endangered creature (including ourselves) on the cover of a magazine, and the message would still be the same. Life should be on the side of life, period.



Dr. Sydney Butler, AZA Executive Director

Photo courtesy American Zoo and Aquarium Association



March 1998 Communique cover

The Tarantula's Tiny Cousin

by David Hodge

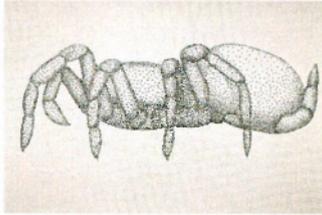


Illustration above and photo opposite page by Joel Harp

Normally, when one thinks of an endangered species, the image of a “charismatic” species such as a bald eagle (*Haliaeetus leucocephalus*) or a tiger (*Panthera tigris*) comes to mind. But some tiny creatures that few people notice are also in trouble. Though small, they are no less important to the biological web that connects all creatures in a particular habitat. Among the little noticed species is a rare spider that lives in the mountains of North Carolina and Tennessee. The spruce fir moss spider (*Microbexura montivaga*) is a primitive species in the suborder Mygalomorphae. Mygalomorphs are spiders that do not spin a web to capture prey, but instead ambush their prey and stab it with their chelicerae (fangs). Mygalomorphs are mostly ground dwelling, although some live in trees in the tropics. *M. montevega* is a tiny cousin of the more familiar large spiders collectively known as tarantulas.

The spruce fir moss spider is a little different from a lot of its spider kin. While many spiders are small, this species reaches a maximum of only 5 millimeters (0.2 inches) at full growth. It also lives only at high altitudes in habitat that is often cool, wet, and snow covered in the winter, conditions that most spiders would not find very suitable. In fact, temperatures in the winter often fall below freezing, yet the little spiders still function under the snow cover. Perhaps their blood contains some type of natural anti-freeze, an advantage that is not unknown in other kinds of animals. The spruce fir moss mat spider has a relative, *M. idahoanna*, which occupies a similar habitat in the mountains of Idaho. Moss spiders get their names

from the moss they live in, which grows in association with spruce fir trees in the mountains. It is this reliance on moss that has put the moss spider in danger of extinction.

In the early 1990's, Joel Harp, a scientist at the Oak Ridge National Laboratory in Tennessee, began a study of *M. montivaga* populations. He found the beginning of a rapid decline in the species' numbers and range: colonies located earlier had disappeared in only a few months. The reasons for the decline have yet to be determined, although it is probably a combination of threats. The main suspect is a tiny mite that is attacking and killing mountaintop spruce trees. With the death of the trees, much of the moss associated with them was lost to desiccation and the moss mat spiders began to vanish. Other possible reasons for the spider's decline include the insecticide lindane, which was sprayed in an attempt to combat the mites, and forest damage resulting from acid deposition.

Fearing the possible extinction of *M. montevega*, Harp and the U.S. Fish and Wildlife Service (FWS) contacted the Louisville Zoo to set up a captive reproduction program. Because the first 12 specimens received were females, we couldn't reproduce them, but we were able to learn about maintaining the spiders in captivity. They were housed in a petri dish with a moist towel and some moss for security. High moisture is very important because these little spiders desiccate rather easily. Temperatures were maintained on the cool side at about 58 degrees F (14 degrees C). Some of the spiders lived to 6 years, which is amazing for such a tiny animal.

After we received male spiders, matings were attempted. With its final molt, the male develops elongated legs and tibial spurs to hold the female's fangs back when they mate face to face. After copulation, the male departs in haste, hopefully to live to mate again. To date, there has been some mating activity but no egg sack production. If we can produce spiderlings, the challenge will be to raise the very tiny offspring to maturity. The adult spiders are fed spring-tails and tiny crickets, but the diet of newly hatched young is still unknown.

In 1995, the FWS listed the spruce fir moss spider as an endangered species. Three months later, the FWS and The Nature Conservancy met to begin work on a plan to save the spider's habitat on Grandfather Mountain, North Carolina, the last place the species was found at the time. Then in 1998, researchers discovered a moss spider population on Mount LeConte, Tennessee, a place where the little animals were thought to have gone extinct. It turns out that after the moss vanished at this site, the spiders found refuge in rocky areas with some plant cover and enough moisture for the spiders to survive. This population may make it possible to reestablish the species elsewhere in its depleted range. There is still DNA and breeding research to be done, but we are hopeful that our efforts will save this tiny spider from the abyss of extinction.

David Hodge is a Keeper with the Louisville Zoo in Kentucky.



by Bob Johnson

Recovery of the Puerto Rican Crested Toad



Photo by Miguel Canals

The Species Survival Plan (SSP) program was originally conceived to provide a blueprint for cooperative and efficient management of captive breeding programs within North America, although SSPs have been developed for many foreign species as well. More recently, the SSP concept has expanded to include field conservation efforts as an integral part of overall conservation and recovery efforts. While captive breeding is not to be considered the sole solution to the recovery of endangered species, conservation biologists have recognized the need for scientifically managed breeding programs in carefully selected cases for some time.

The Puerto Rican crested toad (*Peltophryne lemur*), once endemic to Puerto Rico and the nearby island of Virgin Gorda, is now only found on Puerto Rico where it occurs in two separate populations. It was the first amphibian to be considered for an AZA Species Survival Plan (SSP). The AZA and the Fish and Wildlife (FWS) have worked closely toward the recovery of the crested toad for over 15 years.

Significant variations in mitochondrial DNA between northern and southern populations suggest that the two populations have been separated for some time. None of the northern breeding sites are protected. Despite continuing searches, no adult toads have been seen in the north since 1988, and some biologists consider the northern population to be extirpated. In the south, there is a single breeding pond located in a former gravel parking area in Guanica State Forest. No more than 1,000 adult toads have ever been seen at this site. Over the past 15 years, the southern population has declined to about 200 adults, not all of which are breeding. Breeding in the wild is stimulated by infrequent heavy rainfalls that provide enough water for the 18-21 days it takes for metamorphosis from tadpole to toadlet.

The long-term survival of *P. lemur* depends on protecting existing breeding sites and establishing additional wild populations. Captive breeding provides an additional source of tadpoles and a genetically diverse back-up population in the event of a disaster at the Guanica site. The release of tadpoles, rather than toadlets, is believed to increase the likelihood of imprinting on the natal pond habitat and allows natural

selection to occur at a stage in which large losses can be buffered by the relatively high numbers of released animals. To date, over 4,000 toadlets and 20,000 tadpoles have been released to the wild. The small size of released toadlets makes follow up on the success of introductions or releases difficult.

Captive breeding activities are complemented with field studies. For example, radiotracking post-reproductive toads determined that individuals moved an average of about 410 feet (125 meters) a night for the first 4 days and traveled a maximum distance of 3.2 miles (2 kilometers). After the initial period of intense movement, toads moved no more than about 32 feet (10 m) and often returned to the same hole even after several nights of foraging. Holes in limestone were preferred refuges, although deep crevices were used during the initial post-reproductive migration period. Other research efforts are focusing on nutritional and veterinary research in captive populations, as well as life history and habitat use.

Twenty zoos and aquariums in the United States and Canada participate in the Puerto Rican toad SSP. They provide resources, expertise, and funding for recovery as well as a genetically and demographically diverse back-up population in the event of a biological catastrophe at the natural breeding site. Funding for implementing the SSP has been provided by the FWS Caribbean Field Office, the AZA's Conservation Endowment Fund, the Canadian Museums Association and Canadian Departments of Foreign Affairs and International Trade. Other contributions have been received from the Toronto Zoo's Endangered Species fund, the

Philadelphia Zoo's "One With Nature" fund, the Columbus Zoo's Riverbanks Zoological Park and Botanical Garden Conservation Fund, the Detroit Zoo, Omaha's Henry Doorly Zoo, the Sedgwick County Zoo, the Saint Louis Zoo, the Toledo Zoo, and the Vancouver Aquarium.

In collaboration with the FWS Caribbean Field Office, the SSP working group recently drafted a proposal for an FWS, Puerto Rico Department of Natural Resources, and AZA conservation partnership in which the goals of the SSP are merged with recovery plan objectives. Our partnership focuses on five objectives: conservation education, pond construction for the release of captive bred toads, research related to captive breeding and release, field research on important habitat, and population and distribution surveys.

Education is of critical importance to the recovery of this amphibian species. The FWS and the AZA are working to prepare and distribute identification leaflets to schools and social centers within the toad's historical range. Additional materials include a field guide to tadpoles, toadlets, and toads; life-size models of toadlets and toads; posters that highlight the importance of the remaining breeding sites and surrounding karst habitat; a slide program; and a video to help people distinguish *P. lemur* from another toad, *Bufo marinus*. Bumper stickers, decals, refrigerator magnets, buttons designed and distributed by students, and a conservation activity book will also increase the profile of this species across the island. Community based conservation initiatives will focus on the only known breeding localities for this species. It is important to remember that very few people in Puerto Rico have seen this threatened species.

Live *P. lemur* are on display at the Mayaguez Zoo (with assistance from Mayaguez University) in Puerto Rico. The SSP team has provided equipment, life support systems for holding and breeding toads, and training so that a



captive breeding program can be established in Puerto Rico. Signs invites zoo visitors to visit the Guanica forest to experience the toad's habitat, and Guanica forest visitors will be invited to visit the Mayaguez Zoo to see the toad. Also, for the first time non-breeding toads are housed at the University of Puerto Rico in Rio Piedras. With public support and continued cooperation among agencies and AZA institutions, the chances for recovery of the Puerto Rican toad will improve.

Bob Johnson is the AZA Puerto Rican Crested Toad SSP Species Coordinator at the Toronto Zoo in Ontario, Canada.

Acknowledgments: Ken Foote, Jim Oland, Susan Silander, Dave Harrelson, Mike Hutchins, Fernando Bird, Miguel Canals, Jose Cuevas, Ernesto Estremera, Miguel Garcia, Enrique Hernandez, Rafael Joglar, Jenny Pramuk, Eli Bryant-Cavazos, Diane Callaway, Graham Crawshaw, Jeff Eitling, Reg Hoyt, Andrew Lentini, Andrew Odum, Elaine Gabura, Andy Snider, Andrew Short, Sean Weseloh.

Usually a light brown, this adult male Puerto Rican crested toad exhibits brighter breeding colors

Photo © Bob Johnson

SSPs are cooperative breeding and conservation programs administered and managed by the American Zoo and Aquarium Association (AZA) and its member institutions. When it is established that a captive breeding program can aid in a species' recovery, an SSP is often developed. The SSP identifies appropriate mates for each breeding pair and determines the number of desired offspring to maintain genetic health within the managed population. At present there are SSPs for the following North American species; Attwater's prairie chicken, black-footed ferret, California condor, Guam rail, jaguar, Mexican wolf, Micronesian kingfisher, Puerto Rican crested toad, red wolf, thick-billed parrot, Virgin Island boa and Wyoming toad.

by Michael Amaral and
Ming Lee N. Prospero

One Zoo, Two Islands, and a Beetle



Photo by Andrea Kozol

The spectacle of nature is always new, for she is always renewing the specters. Life is her most exquisite invention, and death is her expert contrivance to get plenty of it.

—Goethe

In the decade since the American burying beetle (*Nicrophorus americanus*) was added to the endangered species list, an impressive number and variety of cooperators have stepped forward to participate in the recovery of this unusual species. What's the attraction? After all, this creature, which makes a living on the dead and decaying flesh of vertebrate animals, is not typically thought of as a charismatic species.

Why the American burying beetle disappeared from more than 90 percent of its historic range is another question. The answer is not clear. Biologists do know that, compared to other members of the genus *Nicrophorus*, the American burying beetle requires the largest vertebrate carcass (e.g., an animal the size of a mourning dove) for successful reproduction. The beetles fly about at night seeking odors that indicate a recently deceased animal. If it is the right size (2.8 to 7 ounces, or 80 to 200 grams), the beetles pair up and bury the carcass, preserving it with special secretions, and the female lays her eggs in the brood chamber. The carcass becomes food for the larvae. Biologists suspect that the American burying beetle's decline may be due to a decreasing availability of suitable carrion and increasing competition for carcasses by other species.

In the eastern United States, reestablishing populations of American burying beetles in selected areas of their historic range is essential for the species'

recovery. In addition, any recovery effort requiring reintroduction must have support from cooperators as well as a continuous source of animals for release. Block Island, 12 miles (19 kilometers) off the southern coast of Rhode Island, is the only remaining natural occurrence of the American burying beetle east of the Mississippi River. But before Block Island beetles could be used in a reintroduction effort, biologists had to be certain that removing some of the beetles for captive propagation would not endanger the island's population.

To address this need, U.S. Fish and Wildlife Service (FWS) biologists joined the Rhode Island Division of Fish and Wildlife, The Nature Conservancy, Boston University, and private landowners in establishing a population monitoring protocol for the American burying beetle on Block Island. With monitoring in place, the FWS and several cooperators moved forward with an ambitious plan to restore the American burying beetle to Nantucket Island, one of the last historic localities for the species in Massachusetts.

A key player in the Nantucket reintroduction effort is the Roger Williams Park Zoo, located in Providence, Rhode Island. The zoo joined the American burying beetle recovery effort in 1994 and began rearing beetles from larvae taken on Block Island. Using nominal start-up financial support from the FWS, the zoo provides space

and care for the captive breeding colony throughout the year. Zoo staff are able to bring their animal husbandry expertise to the beetle project. In turn, staff members gain valuable experience in field research techniques and release methods that can be applied to other conservation endeavors. In the past 5 years, the Zoo has successfully reared more than 20 generations of beetles. With the Massachusetts Division of Fisheries and Wildlife and a private cooperating land owner, the Massachusetts Audubon Society, the FWS has reintroduced more than 350 American burying beetles raised at the Providence Zoo to Nantucket Island, a place famous for its colonial whaling history and popular as a summer beach vacation destination.

To stimulate the beetles to breed, zookeepers painstakingly provide pairs of beetles with all the necessary ingredients and their own honeymoon suite. This entails preparing individual buckets with compact soil, a fresh quail carcass, the right temperature, and a bit of matchmaking. If all goes well, larvae will hatch after a few days and be tended by their parents. The young larvae cannot eat on their own and will solicit feeding from the adults by stroking their parents mandibles. When the larvae are 12-15 days old, they tunnel farther into the ground where they enter a pupal stage for about 6 to 8 weeks. After the pupal stage is complete, they emerge above ground as shiny red and black adult beetles.

The popular conception of conservation biology evokes an image of a lone biologist working in a distant land, such as a tropical rain forest. The Roger Williams Park Zoo understands that there are also many projects that need our attention and support in our own backyard. From the zoo's perspective, the beetle project is an excellent way to contribute to the conservation of a local endangered species.

In December 1998, the American burying beetle became a celebrity insect. The beetle and the FWS recovery

work were featured in a "Wild Discovery" television program, entitled "Weird Worlds." Many of the close-up shots of the beetles tending their larvae were obtained by the Powderhouse Productions film crew at the Roger Williams Park Zoo.

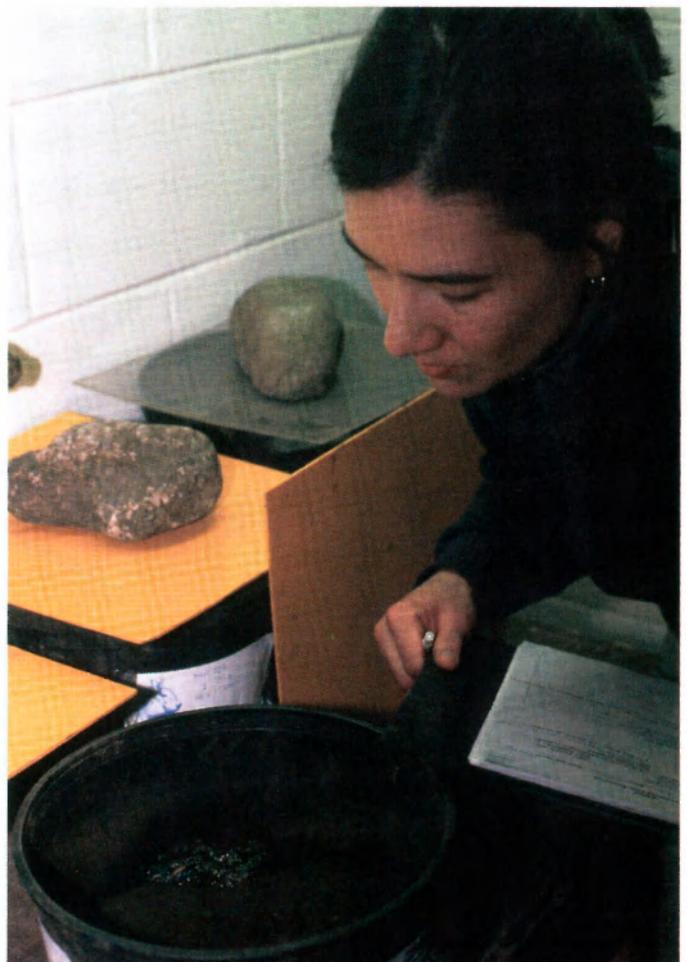
The partnership between the FWS and the zoo can serve as a model for other institutions to collaborate on conservation efforts like the American burying beetle. With our State, private conservation agency, and zoo cooperators, FWS biologists are hopeful that these efforts (and similar ones in other parts of the country) will restore the American burying beetle as the ultimate vertebrate recycler in the insect world.

Michael J. Amaral is the Senior Endangered Species Specialist with the FWS New England Field Office and Ming Lee N. Prospero is an Animal Keeper at the Roger Williams Park Zoo in Providence, Rhode Island.



Ming Lee Prospero checks brood of American burying beetles

Photo above and below by Grant West/Roger Williams Park Zoo



Bog Turtles, Southern Style

by Bern W. Tryon



Photo by R. G. Tuck, Jr.

Anyone who has visited the Great Smoky Mountains on the North Carolina-Tennessee border or driven along the Blue Ridge Parkway in North Carolina and Virginia can appreciate the vast, rugged, natural beauty of the Southern Appalachians. It is also a region of outstanding biological diversity in which new scientific discoveries continue to be made. Fitting together the pieces of the ecological puzzle for any rare species can be a time consuming and often frustrating process, one sometimes compounded in these mountains by the rugged terrain and increasing development.

An example of these challenges is the case of the bog turtle (*Clemmys mublenbergii*). The northern population of this elusive species, found at isolated sites scattered from New York and Massachusetts to Maryland, was listed in 1997 as threatened. The southern population, which is not considered by the Fish and Wildlife Service to be in danger of extinction, is listed as threatened due to its similarity of appearance to the northern bog turtle. In the south, bog turtles are restricted to small remnants of wetland habitat tucked away in the mountains and Piedmont of North and South Carolina, Virginia, Georgia, and Tennessee. Most of what is now known of the bog turtle in the south was brought to light only during the past several decades. For this species, zoo personnel and their associates have played an integral role in putting the pieces of the puzzle together.

Although the bog turtle was first found here in the 1880's, it wasn't until the early 1970's that surveys were initiated in North Carolina, now considered the stronghold for the species in the south. The Highlands Biological Station and the National Audubon

Society enlisted Robert T. Zappalorti, then of the Staten Island Zoo, to conduct a series of surveys in western North Carolina. Accompanying Zappalorti on some of these trips was Dave Collins, then of the Burnet Park Zoo in Syracuse, New York, and now Curator of Forests at the Tennessee Aquarium. Zappalorti, Collins, and their colleagues found a number of important turtle sites. Although some of these sites no longer exist, others have been used over the years to document problems for bog turtles such as vegetational succession in the habitat, bog destruction due to development, and turtle poaching. Zappalorti's 1975 book, *An Amateur Zoologist's Guide to Turtles and Crocodilians* (Stackpole Books), includes photos of bog turtles from some of these early surveys.

A name synonymous with bog turtles in North Carolina, and indeed throughout the species' southern range, is Dennis Herman, who for over two decades as a herpetologist at Zoo Atlanta established himself as not only the region's leading expert but also a champion for turtle and habitat protection. Herman picked up where Zappalorti left off, and in the years since then he and his associates have been responsible for documenting bog turtles in over half of the 20 North Carolina counties known to harbor the species. In 1995, in an effort to unify field studies within the State, Herman founded Project Bog Turtle, sponsored by the North Carolina Herpetological Society and the North Carolina State Museum of Natural Sciences, where he is now Curator of Living Collections. This important initiative has combined statewide efforts for the species, maintains a data base for bog turtles in the south, and has been instrumental in assisting the conservation efforts of

private landowners through easements, habitat maintenance, and education.

As part of Project Bog Turtle, Herman and his colleagues continue to play a large role in identifying new turtle sites throughout the species' southern range. In the early 1990's, Herman and I joined forces with George Amato and John Behler of the Wildlife Conservation Society/Bronx Zoo in a study of turtle genetics. In a 2-year period, we were able to collect blood samples from 64 bog turtles representing all 5 States in the southern range as well as samples from Maryland and Delaware. An examination of mitochondrial DNA showed no differentiation among populations, but additional analysis will soon be underway.

My own program had its start when Herman, along with Jim Warner (a bog turtle expert from Connecticut), discovered the first bog turtle in Tennessee in May 1986. We quickly identified the only two turtle sites in Tennessee known to date. The Tennessee project has not only encompassed 14 seasons of field work but a captive breeding element as well. In late 1986, a large, naturalistic outdoor bog exhibit was constructed at the Knoxville Zoo, providing an attractive facility for environmental education and for raising bog turtles. (The American Zoo and Aquarium Association awarded the Knoxville Zoo its Significant Achievement Award for this exhibit in 1989.) The Knoxville Zoo's captive breeding program has produced 103 bog turtles since 1988. Working with the Tennessee Wildlife Resources Agency (TWRA), the zoo developed a head-start/release program. Since 1991, 84 captive-bred turtles have been released into a large site in a neighboring county.

In any wildlife endeavor, the value of partnerships cannot be underestimated. Here in Tennessee, the Knoxville Zoo, TWRA, The Nature Conservancy of Tennessee (TNC), and the U.S. Fish and Wildlife Service (with support and funding from Asheville, North Carolina, Field Office through the

Partners for Fish and Wildlife Program) have joined forces to establish the bog turtle as a flagship species for a rapidly disappearing wetland ecosystem. Only three percent of the State's naturally occurring wetlands are found in eastern Tennessee and a tiny fraction of this includes bog turtle habitat. Through the combined efforts of these organizations, especially TNC, a 65-acre (26-hectare) habitat restoration project now underway in rural Tennessee may help to provide a bright future for bog turtles in this State.



Bern Tryon is Curator of the Department of Herpetology at the Knoxville Zoo.

Photo by Bern W. Tryon

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Return of a Native

by Peter J. Tolson,
Mitchell L. Magdich,
Terry Seidel,
Gary A. Haase, and
Buddy Fazio



Karner blue butterfly caterpillar

Photo by Ann B. Swengel

The Karner blue butterfly (*Lycaeides melissa samuelis*) has suffered catastrophic population declines in the past 100 years, disappearing from almost 99 percent of its historical range. It is now extirpated in Illinois, Massachusetts, Pennsylvania, and Ontario. The Fish and Wildlife Service (FWS) listed the Karner blue as endangered in 1992. This living jewel is a signature species of the oak savanna ecosystem, an endangered habitat characterized by meadows of prairie plants dispersed among stands of widely spaced oaks.

Oak savanna in Ohio is limited to a small region of northwestern Ohio known as "the Oak Openings." This region has special relevance to the State of Ohio because it contains more endangered species than any other part of the State. Certain agricultural practices, fire suppression activities, and drainage projects have severely modified this area, allowing encroachment on open areas by trees and exotic plants. These habitat changes extirpated many rare and unique taxa, including the Karner blue butterfly, which requires oak savanna habitat with extensive patches of wild lupine (*Lupinus perennis*). The Karner blue was last seen in Ohio in 1988 within the Oak Openings region.

Since 1992, in a partnership with the Ohio Department of Natural Resources (ODNR) and the Michigan Department of Natural Resources (MDNR), the FWS, Toledo Zoological Gardens (TZG), and The Nature Conservancy (TNC) have been preparing for a reintroduction of the Karner blue to the Oak Openings of Lucas County, Ohio. This long-term effort began with propagation of more than 5,000 wild lupine, the host plant for Karner blue larvae. At the same

time, TNC began extensive habitat restoration efforts that cleared woody vegetation and exotic plants from Kitty Todd Preserve, allowing stands of wild lupine to regenerate. By 1995, restoration of the oak savanna at Kitty Todd had proceeded to the point that a release of the butterfly was feasible. Our partnership then made a detailed study of microhabitat requirements at the Allegan State Game Area in Michigan to ensure that habitat in the Kitty Todd Preserve could support populations of the Karner blue. Statistical analysis of these data indicated that target release areas on the Kitty Todd Preserve did not differ significantly from the localities in the Allegan State Game Area that supported large flights of the Karner blue, at least in terms of microhabitat environments and densities of lupine and nectar plants.

We elected to use breeding and release rather than translocation as a strategy for reintroduction of the Karner blue, as we believed that we could release many more butterflies on the preserve after breeding them in a zoo. The Melissa blue butterfly (*Lycaeides melissa melissa*) was selected as a model species to perfect breeding

techniques, and it successfully bred and overwintered at the TZG with no apparent problems. In May and June 1998, adult female Karner blues were collected by MDNR, ODNR, and TZG staff from the Allegan State Game Area for breeding. From these individuals, 592 eggs were produced in the zoo's butterfly-breeding facility, resulting in 341 adults.

We transported potted lupine plants containing larvae and pupae (protected with netting) to the Kitty Todd Preserve in late June 1998. A total of 164 adults metamorphosed from this group and were released from June 29 through July 14, 1998. The release coincided with the peak flowering of New Jersey tea (*Ceanothus americanus*) on the preserve, and the newly released butterflies were seen feeding in the extensive stands of this important nectar plant. We observed the first eggs laid in the wild on July 21, 1998, and in May 1999 wild-bred Karner blues were flying again at the Kitty Todd Preserve. We

collected additional Karner blues in May and June of this year, and we'll continue through 2002 to bolster the numbers and genetic diversity of the reintroduced population.

The dedication to restore the Karner blue to Ohio is shared by an active coalition of conservation partners. With luck, additional habitat management, and the additional releases planned over the next 5 years, it is our hope that the Karner blue butterfly will again become a permanent resident of Ohio's Oak Openings.

Peter J. Tolson is the Conservation Biologist at the Toledo Zoological Gardens and Mitchell L. Magdich is the Curator of Education. Terry Seidel is the Oak Openings Program Coordinator for the Ohio Chapter of The Nature Conservancy and Gary Haase is the Conservancy's Oak Openings Land Steward. Buddy Fazio is a Biologist with the FWS Ecological Services Field Office in Reynoldsburg, Ohio.

Photo by Joel Trick



Conserving a Treasure of Diversity

by Paul D. Johnson and
Robert S. Butler



Young captive propagated tan riffleshells, an endangered mollusk (in flask), about to be released into the Hiwassee River in east Tennessee

Photo by Richard Biggins/USFWS

Resource managers often face difficult challenges dealing with the effects of modern development on wildlife and its habitat. While most of these challenges are involve "high-profile" vertebrate species, a major conservation effort is underway to preserve an entire group of highly threatened invertebrate animals. Freshwater mollusks are the most threatened taxonomic group in United States today, and they are beginning to receive the attention that they deserve.

The southeastern United States is the global epicenter of freshwater molluscan diversity. Although they are not the most charismatic creatures, freshwater snails and mussels represent an enormous proportion of our Nation's aquatic wildlife. Because these animals are long-lived (up to 100 years for some mussel species) and very sensitive to environmental impacts, they are excellent indicators of short-term and long-term water quality. Mollusks are found throughout the Mississippi River basin and the Atlantic Coast drainages, but the center of their North American distribution is a region that encompasses the Cumberland, Tennessee, and Mobile river drainages. However, this region has seen major riverway modifications, habitat alterations, and invasive species introductions that have taken their toll on our native freshwater mollusks.

Nearly 70 percent of the 297 species of freshwater mussels native to North America are listed as extinct, endangered, threatened, or of special concern. To date, 30 species are considered extinct and many others have not been seen in years. While several biologists are working hard to assess the conservation needs of freshwater mussels, few are studying the conservation status of another large mollusk resource: native freshwater snails. The recent loss of freshwater snail diversity in North America is truly stunning; 42 species of native freshwater gastropods are considered to be extinct. This includes all species belonging to the genera *Clappia*, *Gyrotoma*, *Amphigyra*, and *Neoplanorbis*, all of which were endemic to the Mobile River basin.

To help deal with the challenges of habitat destruction and dwindling

populations of native freshwater mussels, the Fish and Wildlife Service's (FWS) Asheville, North Carolina, Field Office has initiated a significant mussel recovery program. Until now, this program focused on the recovery of the Cumberlandian Region mussel fauna, which includes species from both the Tennessee and Cumberland river systems. This region contains more species of freshwater mussels than any other drainage in the world. In cooperation with the U.S. Geological Survey's Biological Resources Division (BRD) Cooperative Research Units at Virginia Tech University in Blacksburg, Virginia, and Tennessee Tech University in Cookeville, Tennessee, FWS recovery efforts with the Cumberlandian Region mussel fauna are well underway.

Recently, a new partner signed on to assist with mussel recovery efforts: the Southeast Aquatic Research Institute (SARI), which is associated with the Tennessee Aquarium, located in Chattanooga, Tennessee. At present, SARI's efforts are focused on artificial propagation and related research that will benefit the mussel fauna of the upper Coosa River system, a portion of the greater Mobile River basin. The Coosa River system may be the site of the largest recent mass extinction event in U.S. history. It is thought that no fewer than 12 species of mussels and 25 species of freshwater gastropods were lost when the river was dammed and modified. Initially, 10 species of mussels endemic to the Coosa River Basin have been targeted by SARI and the FWS for potential restoration.

Most of SARI's field work has been in the Conasauga River section of the upper Coosa River system in north

Georgia and adjacent Tennessee. Numerous stakeholders, including the FWS, SARI, The Nature Conservancy, Conasauga River Alliance, and the Limestone Valley Resource Conservation and Development Council, have formed a unique partnership for riparian habitat restoration and mussel recovery. In its first year, the program is constructing the facilities needed to hold and artificially propagate freshwater mussels. With the additional support of the BRD "Species-At-Risk" program and the FWS Jackson, Mississippi, Field Office, a large-scale mollusk survey project of the Conasauga River is underway. This survey has boosted the propagation program by providing locality data that can help identify where potential broodstock is now located and suitable locations where artificially propagated mussels might be reintroduced. Indeed, one of the largest impediments to mussel recovery efforts in the upper Coosa River system has been the absence of up-to-date survey data.

Getting the word out to a diverse array of citizens about freshwater mollusk and riverine habitat conservation initiatives has always been a challenge. Recently, the FWS Jackson Office, SARI, the Tennessee Aquarium, and the University of Georgia's Institute of Ecology (UGIE) teamed up to produce *A Stakeholders' Guide to the Conasauga River*. The stakeholders' guide focuses on the values and qualities of healthy flowing streams and the conditions that threaten them. The guide informs stakeholders about how they can protect riverine resources, not just for the sake of nature, but to improve the quality of human life as well. To date, thousands of the guides have been distributed.

A similar guide is also being produced by SARI, UGIE, and the FWS Asheville Office for the Etowah River in northern Georgia, another upper Coosa River tributary. This guide is being produced in cooperation with the newly formed Upper-Etowah River Alliance. The Alliance is dedicated to protecting

this increasingly threatened watershed, located at the northern fringes of rapidly growing greater Atlanta. The Etowah River provides habitat for 13 species of federally protected mussels and fishes, including two species of darters found nowhere else in the world.

Another mollusk recovery effort initiated by the FWS Jackson Office and SARI involves the plicate rocksnail (*Leptoxis plicata*). Listed in 1998 as endangered, this small snail is known to occur on a few shoals along an 11-mile (18-kilometer) stretch of the Locust Fork of Black Warrior River above Tuscaloosa, Alabama, a portion of the Mobile River Basin. The Mobile River basin contains the most diverse temperate freshwater snail fauna in the world, but some 39 species in the basin have disappeared in recent times. For the first time, researchers are attempting to establish a captive breeding population of riverine snails. If successful, juvenile snails produced by the parent stock will be used to establish new populations in the species' former range. Two captive colonies of plicate rocksnails have been held since September 1998. To date, the snails are displaying good survivorship and growth in their artificial environment, and we hope they will begin to reproduce soon. In the meantime, researchers intend to study the specific habitat requirements of the plicate rocksnail in preparation for selecting possible reintroduction sites.

Along with habitat restoration and public awareness efforts, breakthroughs in propagation techniques provide hope for the reversal of biodiversity loss for North America's freshwater mussels and snails. Together, SARI, the Tennessee Aquarium, and the FWS are working hard to assist this unique regional natural resource

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The federally endangered rough rabbitsfoot mussel survives in a few tributaries of the upper Tennessee River system in southwestern Virginia and eastern Tennessee.

Photo by Richard Biggins/USFWS

The Wyoming Toad SSP

by Brint Spencer



USFWS photo



Mortenson NWR

USFWS photo

The origin of the Wyoming toad can be traced to about 10,000 years ago when it became isolated from its ancestral stock, the Manitoba or Canadian toad (*Bufo hemiophrys*), around the end of the Pleistocene Epoch. The ranges of the two species are separated by approximately 500 miles (800 kilometers). The Wyoming toad currently is found only in the State's Laramie Basin. This burrowing animal inhabits floodplains, ponds, and ditches in the short grass regions of the basin.

Wyoming toads (*Bufo hemiophrys baxteri*) were once abundant in the wetlands and irrigated meadows of Wyoming's southeastern plains. However, by the 1970's the population had declined drastically and was confined to privately owned lands surrounding Mortenson Lake. In 1984, the Fish and Wildlife Service (FWS) recognized the species' precarious status by listing the Wyoming toad as endangered. To protect the last population, The Nature Conservancy (TNC) stepped in and purchased the lake and surrounding lands, totaling approximately 1,800 acres (730 hectares). But populations continued to decline, and by 1994 the species was extinct in the wild. Only captive populations remained.

In December of 1996, the American Zoo and Aquarium Association (AZA) approved a Species Survival Plan (SSP) that formalized a cooperative program of the AZA, FWS, and Wyoming Game and Fish Department (WGF). This program was designed to restore the Wyoming toad, one of the most endangered amphibians in the United States, to a secure status in the wild.

The reintroduction story began in 1988, when a small number of toads were taken from Mortenson Lake to WGF facilities for captive breeding. In 1992, the FWS purchased some of the Wyoming toad's last habitat from TNC and established the Mortenson National Wildlife Refuge (NWR). That same year, tadpoles and toadlets were released at Lake George and Rush Lake on Hutton NWR in an effort to establish a second wild population. By 1994, it was apparent that emergency measures were needed. In an effort to prevent the animal from becoming extinct, the last remaining toads were captured and a

more intensive captive breeding program was initiated. The captive population greatly increased by 1995, with the help of several AZA affiliated zoos and the WGF facilities.

Wyoming toads are now housed at eight AZA affiliated zoos: Central Park (NY), Cincinnati (OH), Detroit (MI), Henry Doorly (NE), Houston (TX), Sedgwick County (KS), St. Louis (MO), and Toledo (OH). Two government facilities, the Saratoga National Fish Hatchery (WY) and Sybille Wildlife Research Center (WY), also have captive populations. Diane Callaway of the Henry Doorly Zoo maintains a species studbook to manage the genetics of the entire captive breeding population. Nearly 600 toads now exist in captivity and there are over 3,000 historical records in the studbook. Each spring, a number of the offspring produced that year are held back for the captive breeding program. The rest are returned to Wyoming, where they are released as tadpoles or toadlets.

Since 1996, the program has produced approximately 10,000 toads for reintroduction into the Laramie basin. Most of the release efforts have focused on Mortenson Lake. Once a viable population has been established there, we will concentrate on other lakes in the area. So far, only a small number of toads have survived to breed. By the spring of 1998, several two-year-old captive hatched and released animals were heard calling at Mortenson Lake. The calls indicated breeding activity in native habitat for the first time since the Wyoming toad was declared extinct in the wild.



The AZA has also been involved in several research projects on the Wyoming toad. A radiotelemetry field study was funded by the AZA Conservation Endowment Fund (CEF) and a Challenge Cost Share Agreement from the FWS was initiated last year to look at microhabitat use. In addition, the Center for the Reproduction of Endangered Wildlife at the Cincinnati Zoo received a CEF grant to study the feasibility of cryopreserving toad sperm. Further, the Nutrition Department of the Wildlife Conservation Society is researching the diets of Wyoming toads living in captivity and in the wild.

Future goals for the recovery effort include increasing the public's awareness of the Wyoming toad's critical status, expansion of the captive breeding program, and additional research. An outreach coordinator has been identified to initiate education programs to reach adults and students in local schools. Two additional AZA zoos have

expressed interest in participating in the captive breeding program. Upcoming research projects will include studies on the effects of temperature and the duration of hibernation, field work to identify toad hibernation sites, and a genetic analysis of captive versus wild bred populations.

Each facet of the Wyoming Toad SSP and recovery program is an integral part in our plan to restore this endangered amphibian to a secure status. With continuing cooperation among AZA institutions, the FWS, and WGF, this effort is achieving promising results. It is an excellent example of how dedicated biologists and resource managers can work together to save a critically endangered species.

Brint Spencer is the Animal Curator at the John Ball Zoo and serves as the SSP Coordinator for the Wyoming Toad.

The Wyoming toad is dark brown, gray, or greenish in color with small dark blotches. Adult Wyoming toads average 2.2 inches (55 millimeters) in length, with the females slightly larger than the males.

Photo © Jeff Vanuga

by Kim Dickerson

Pesticides and the Wyoming Toad



Wyoming Toad Stamp Sends a Conservation Message

by Ann Haas

Stamps of 15 endangered species, including the Wyoming toad, representing amphibians, were among the most popular with collectors in 1997, according to the U.S. Postal Service. Hobbyists saved 28 million of the endangered species set.

The other endangered species depicted on the 32-cent stamps are the black-footed ferret, thick-billed parrot, Hawaiian monk seal, American crocodile, ocelot, Schaus swallowtail butterfly, brown pelican, California condor, Gila trout, San Francisco garter snake, woodland caribou, Florida panther, piping plover, and West Indian manatee. The range of wildlife—birds, mammals, and marine mammals, along with a fish, a reptile, an insect and an amphibian—illustrate the importance of a variety of initiatives to conserve our land and water to ensure biological diversity. The Fish and Wildlife Service and the National Marine

The preceding article on efforts to recover the Wyoming toad highlights the captive breeding and release program. However, the reintroduction of this species is not enough to secure its future. Until we understand and address the reasons for its decline, the Wyoming toad's survival in the wild is far from guaranteed. Possible causes include climate change, increased predation, changes in agricultural practices, disease, and pesticide use.

For more than a decade, biologists have looked into possible environmental causes of the toad's decline. Studies conducted at Mortenson National Wildlife Refuge (NWR) by our Cheyenne, Wyoming, Field Office's Environmental Contaminants Division during 1989-1991 showed that concentrations of trace elements in water, sediment, and vegetation were below levels harmful to the Wyoming toad. Studies conducted by the Wyoming Game and Fish Department revealed that predation, habitat modification, and soil and hydrologic conditions were not identified as serious threats to the toad. The Wyoming State Veterinarian Laboratory confirmed that the bacterial disease "redleg" was present in the Wyoming toad population, but the lab was unable to determine if this disease was a cause for the drastic population decline.

In 1998, our Cheyenne office conducted a study to determine if pesticides were entering Mortenson NWR through aerial drift and affecting the Wyoming toad. During the 1970's and early 1980's, fenthion (Baytex) was sprayed for mosquito control on lands adjacent to Mortenson NWR. This pesticide was subsequently not re-regis-

tered with the Environmental Protection Agency after 1992 for use as a mosquitoicide and therefore was taken off the market. It was replaced with malathion, which is very toxic to fish, amphibians, and aquatic invertebrates, although less so than fenthion. Coincidentally, the last toad population was found in 1987 on lands of the future Mortenson NWR adjacent to a ranch that did not spray for mosquitoes.

To determine if aerial drift was occurring and what effects malathion would have on Wyoming toads in their natural environment, we used a non-endangered species, Woodhouse's toad (*Bufo woodhousii*), as a surrogate for research purposes. Because side effects of a non-lethal dose of malathion include lethargy, intoxication, and paralysis, it is important to know if the pesticide is affecting the toad's ability to escape predation. To have a basis for comparison before and after the non-lethal dose, we conducted behavioral tests called "righting trials," in which the toads are flipped onto their backs to see how long it takes to right themselves. We also took blood samples from some of the toads to compare the level of cholinesterase activity in toads before

and after spraying. Cholinesterase is an enzyme essential for normal nerve function. Certain pesticides, such as malathion, inhibit cholinesterase activity. A significant decrease in the enzyme's activity usually leads to uncontrolled tremors, convulsions, and ultimately death. Pesticides that affect cholinesterase activity attack the nervous systems of all animals:

It was also important to determine if the adult Wyoming toad's food source was being reduced by aerial drift of pesticides. Adult Wyoming toads primarily eat ants and beetles, but they will also consume aquatic insects. To collect terrestrial insects, we placed insect pitfall traps at sampling sites overnight for two consecutive nights prior to spraying. Pitfall traps are containers set into the soil so that their tops are flush with the surrounding ground. Insects fall into the trap but are unable to get out. We also collected aquatic invertebrates from each site. We recorded the species and quantity of terrestrial and aquatic insects captured to estimate the total abundance of insects and the number of individual species. Insects were submitted for chemical analysis prior to the spraying so that results can be compared to chemical levels found in insects collected after the pesticide spraying.

On the day prior to spraying activities, we attached pesticide indicator strips and filter paper spray cards to fence posts at each sampling site and at a control site where we knew aerial drift of pesticides would not occur. Indicator strips are used to detect pesticide exposure and filter paper spray cards are used to determine the concentration of pesticide drift entering the site. Immediately before spraying began, we put the surrogate Woodhouse's toads in wire mesh enclosures and placed them alongside the same fence posts as the indicator strips and filter paper spray cards. We also set insect pitfall traps.

After the spraying was completed, we gathered the material. Eleven of 80 indicator strips showed evidence of

aerial drift. Therefore, we submitted the filter paper spray cards to a laboratory for analysis of malathion concentration. We also submitted the filter paper spray cards from the reference site. A canvas of our study areas revealed no dead or dying insects. We then repeated our collections of terrestrial and aquatic invertebrates and submitted them for analysis of malathion. We also collected the surrogate toads and repeated the righting trials. Results of the post-spraying righting trials did not differ significantly from those seen prior to the spraying. After weighing the toads, we took blood samples and sent them along with the toads to the laboratory for analysis of cholinesterase inhibition.

Although we are still awaiting the analyses, we are hopeful that the data will be useful for guiding management decisions regarding pesticide use on lands bordering Mortenson NWR and thereby help make toad reintroduction efforts successful. The FWS Environmental Contaminants Division plays a significant role in this cooperative effort among the FWS, Wyoming Game and Fish, and AZA members. Through the combined efforts of these partners, the outlook for the endangered Wyoming toad is now promising.

Kim Dickerson is a Wildlife Biologist with the FWS Cheyenne, Wyoming Office.

Fisheries Service work closely with State and Federal agencies and private organizations to conserve endangered species.

In simultaneous ceremonies in California and Mexico City celebrating Stamp-Collecting Month, October 1996, the San Diego Zoo and the Mexican Postal Administration jointly initiated distribution of endangered species stamps highlighting the theme, "Collect and Protect." In this country, the Postal Service issued 223 million of the stamps featuring photographs by James Balog of Boulder, Colorado, whose work has been published in the *National Geographic* magazine, among others.

Ann Haas is a Writer/Editor with the FWS Division of Endangered Species in Arlington, Virginia.

Photo © Jeff Vanuga



by Mike Demlong

Beyond Captive Propagation



Shell of the Kanab ambersnail

Photo by Jeff Sorenson/Arizona Game and Fish Department

For native species like the black-footed ferret (*Mustela nigripes*), California condor (*Gymnogyps californianus*), and Mexican wolf (*Canis lupus baileyi*), the role of zoos and aquariums in partnership recovery efforts seems fairly straightforward. Our roles include propagating animals for reintroduction to native habitats and interpreting the plight of these species and their ecosystems for our millions of visitors. But our efforts extend well beyond captive propagation and visitor awareness. Zoo and aquaria staff throughout North America also contribute to the recovery of native species by participating in habitat renovation, population surveys, basic research, control of non-native species, interpretive materials design, and maintaining genetic refugia. The Phoenix Zoo has been active in many of these areas, some examples of which follow:

Kanab Ambersnail

The Kanab ambersnail (*Oxyloma haydeni kanabensis*) is an endangered terrestrial mollusk with only three known populations, all in the American Southwest. Two populations inhabit privately owned wetlands in southern Utah, and the third lives at a large spring along the Colorado River in Grand Canyon National Park. Human activities such as groundwater pumping, commercial development, and livestock grazing potentially degrade the snail's habitat on private land, while large water releases from Glen Canyon Dam could threaten the Grand Canyon population. To promote the recovery of this snail and protect it from future human-related threats, the Kanab Ambersnail Working Group was formed.

This is an informal group with diverse membership including Federal and State agencies, university researchers, and non-governmental facilities such as the Phoenix Zoo. In addition to recovery planning, zoo staff have been fortunate to participate in habitat and population surveys and the translocation of snails to new sites in the Grand Canyon.

One role of The Phoenix Zoo in supporting the recovery plan has been to create and maintain a refugia population. Although there are no plans to use the captive animals for future reintroduction, the option exists should a rare catastrophe eliminate the Grand Canyon population. Staff from the zoo and Arizona Game and Fish Department designed and created two outdoor refugia, complete with a dripping spring, host plants collected from the canyon, and the appropriate sandstone substrate. A public exhibit with interpretive information is scheduled to open in the fall of 2000.

Native Fish

The introduction of exotic sport fish and the diversion or impoundment of southwestern rivers has contributed to the extirpation, or some cases extinction, of many native fish species. The Phoenix Zoo grounds contain a series of artificial lakes, ironically filled decades ago with water diverted from a now dry river that once flourished with native fish species. In partnership with biologists from Arizona State University, the American Zoo and Aquarium Association's Freshwater Fish Taxon Advisory Group, the Fish and Wildlife Service (FWS), and the Arizona Game and Fish Department, zoo staff created

a plan to use one of the lakes as a refugium for endangered native fish.

The zoo's main lake was chosen due to its central location (a natural focal point for our visitors) and size (approximately 15 acre-feet). FWS fishery biologists assessed the lake and found it suitable as long-term habitat for a population of endangered bonytail chubs (*Gila elegans*) and razorback suckers (*Xyrauchen texanus*). Our objectives were to create a genetic or broodstock refugium and to "head start" juvenile fish in a semi-natural environment. The plight of native fish in the wild and the zoo's role in their recovery are explained on large interpretive panels around the lake. Each of the panels displays life-size sculptures of the fish that inhabit the lake. Before juvenile native fish were released, the exotic sportfish in the main lake were removed to



other urban lakes. The lake was then drained and refilled with water filtered through a passive gravel bed to impede the reinfestation of sportfish. Approximately 200 bonytail chub and 5,000 razorback suckers reared at Dexter National Fish Hatchery and Willow Beach National Fish Hatchery were released into the lake in the summer of 1996. By the fall of 1998, some of the fish had reached a predator safe, sexually mature size and over 100 razorbacks were returned to their historic range in the Colorado River. Another release of fish head-started at the zoo is planned for this year.

In addition to bonytail chubs and razorback suckers, the zoo also maintains three other ponds for desert pupfish (*Cyprinodon macularius*) and Gila topminnows (*Poeciliopsis occidentalis*). Although these species were originally established at the zoo as refugia or research populations, the pupfish and topminnow also provide the unexpected benefit of natural mosquito control for the zoo. Also, a small group of adult and juvenile pupfish will be moved to Cibola

National Wildlife Refuge to establish another refugium population.

Southwestern Frogs

Many of the environmental issues that threaten native fish likewise affect native amphibians. Phoenix Zoo staff and volunteers are active partners



Staff from Dexter National Fish Hatchery releasing juvenile endangered fish, such as the razorback sucker (inset), into zoo's main lake

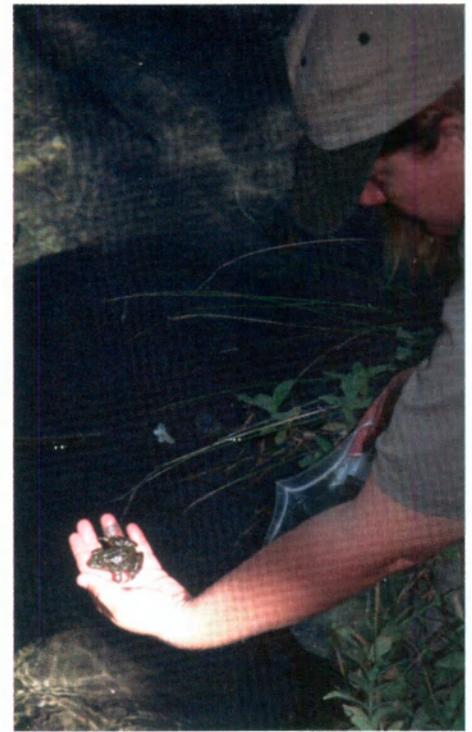
Above: Photo by Dick George/The Phoenix Zoo
Inset: USFWS photo

in the conservation and management of four native southwestern aquatic frogs. Other partners include the FWS, Arizona Game and Fish Department, U.S. Forest Service, Department of the Army, Bureau of Land Management, The Nature Conservancy, and private landowners. Species of concern include the Tarahumara frog (*R. tarahumarae*) and the Chiricahua (*Rana chiricahuensis*), northern (*R. pipens*), and Ramsey Canyon leopard frogs (*R. subaquavocalis*). The Tarahumara frog has been extirpated from the State and the other species are experiencing severe declines. The Phoenix Zoo's conservation efforts with leopard frogs are as diverse as the partnerships, and they range from recovery planning to captive rearing.

One conservation strategy the zoo has helped refine is a head-starting technique. Due to high predation and mortality of frog embryos and larvae, small portions of egg masses are removed from the wild and cared for at the zoo's Montane Anuran Conservation Center (MACC) until they metamorphose. The MACC was built from two

recycled ocean cargo trailers that have been fitted with air conditioning, banks of full-spectrum lighting, and a series of plastic pools with separate filtration and aeration systems. These buildings are treated as quarantine facilities and are cared for primarily by a group of volunteers known as "The Tadpole Taskforce." Frogs reared in the center are toe-clipped for future identification and returned to the original egg collection site. Survivorship from embryo to newly-developed frog at the facility is remarkable high, over 90 percent, and the staff have produced and released over 3,000 animals (as of spring 1999) to supplement severely declining wild populations. Thus far, at least two animals head-started at the zoo have reproduced at one release site.

Rearing frogs for wild release is only a small part of the zoo's effort to protect native frogs and their ecosystems. Staff and volunteers spend considerable time participating in population monitoring, habitat renovation, non-native species removal (e.g. bullfrogs), making community presentations, and recovery planning. Additionally, staff have made significant discoveries about captive husbandry, dietary needs, larval growth



(Right) Phoenix Zoo volunteer releasing a head-started Ramsey Canyon leopard frog into Ramsey Creek on property owned by The Nature Conservancy

Photo by Teresa Azzato/The Phoenix Zoo

rates, stocking densities, and life support system design.

Our most important contribution to frog conservation is creating public awareness of the precarious plight facing amphibians locally and globally. We engage zoo visitors and the general public using color posters at environmental fairs, print and video media interviews, community presentations, behind-the-scenes tours of the conservation center, video production, and an interactive box of interpretive material available for loan to schools.

Whether it's a snail, fish, or frog, our nation's zoos and aquaria often do much more for wildlife than captive propagation. Just ask us!

Mike Demlong, formerly the Ectotherm Curator at the Phoenix Zoo, is now the Amphibians and Reptiles Program Manager for the Arizona Game and Fish Department.

An adult Ramsey Canyon leopard frog

Arizona Game and Fish Department photo





Fish and Wildlife Service (FWS) regional endangered species staffers have reported the following news:

Region 1

Humboldt Bay NWR Outreach efforts involving the control of noxious weeds continue at Humboldt Bay National Wildlife Refuge (NWR). Refuge Ecologist Andrea Pickart, Biological Technician Abe Walston, and volunteer Kyle Wear recently participated in "Alien Invaders Day" at the Arcata Natural History Museum. Walston produced a display on biodiversity and Pickart produced "Wanted: Dead Not Alive" flyers for the "dirty dozen" non-native species.

Approximately 40 students from the Universities of Montana and Utah recently spent a day on iceplant (*Carpobrotus edulis*) control at the Lanphere Dunes Unit of Humboldt Bay NWR as part of their week-long alternative spring break program, "Breakaway." They also worked a day under Pickart's direction on the control of eastern beachgrass (*Ammophila breviligulata*), another non-native plant.

Habitat Conservation Staff from the FWS Ventura, California, Office have been working with several public and private partners over the past few months to conserve coastal wetlands, dunes, and endangered species habitat in the Ormond Beach area of Ventura County. Some highlights follow: 1) with help from the Boy Scouts, we removed dilapidated fencing at the site of a nesting colony of endangered California least terns (*Sterna antillarum brownii*); 2) with Oxnard City Corps (a youth development group), we will be installing a new and mobile protective barrier around the tern colony; 3) with California Lutheran University, we are studying environmental contaminants, soils, and vegetation at estuarine restoration areas;

and 4) with the Oxnard Police Department, we are developing a training video and enforcement protocols for protection of the tern colony.

Some of the funding for these activities comes from partnerships with the Ventura County Fish and Game Commission, City of Oxnard Redevelopment Committee, and Southern California Edison through an FWS Challenge Cost-share Grant. The Ormond Beach Observers, a citizen's group, organizes outreach efforts. Other State and federally listed species that will benefit from these efforts include the western snowy plover (*Charadrius alexandrinus nivosus*), Belding's savanna sparrow (*Passerculus sandwichensis*), and salt marsh bird's beak (*Cordylanthus maritimus* ssp. *maritimus*), an annual plant.

Threats to the habitat include impacts from industry, recreation, and development. The Southern California Wetlands Partnership (formerly known as Wetlands Clearinghouse), a cooperative State/Federal effort to restore and preserve southern California wetlands, now lists Ormond Beach as a high priority. In addition to participating with the Clearinghouse, our Ventura Office has been involved in several Ormond Beach conservation efforts with a multitude of cooperating partners, including: the Oxnard City Corps (teens and young adults volunteering in the community), Southern California Edison and Houston Industries (landowners and generating station operators at Ormond Beach), California Lutheran University, Ventura County Fish and Game Commission, and California Department of Fish and Game.

San Luis NWR Complex This spring, our Partners for Fish and Wildlife Program began its 1999 construction season at the San Luis NWR Complex. Two major restoration efforts are on the San Felipe Ranch and on the Kulwant Somal property. The San Felipe project will restore 2.5 miles (4 kilometers) of Owens Creek and associated flood plain. The Somal project will restore 180 acres (73 hectares) of seasonal wetlands and associated uplands in the North Grasslands.

Po'ouli (*Melanerpes formicivorus*) In an effort to prevent the extinction of this severely endangered Hawaiian forest bird, the FWS and State of Hawaii are proposing intensive habitat management and the translocation of one or more individuals. Endemic to the island of Maui, the po'ouli currently



Po'ouli

Photo by Paul Baker

is found only in a restricted area of the island's remaining rainforest. This species has been declining since its discovery in 1973, and the total population may number no more than three individuals. From the six management proposals considered, we selected a combined alternative: continue and intensify habitat management to reduce or eliminate threats to the birds in the action area and, if necessary and feasible, conduct translocation(s) in an attempt to bring isolated birds together to form a breeding pair

Reported by LaRee Brosseau of the FWS Portland Regional Office.

Region 5

Bats In cooperation with the New Jersey Division of Fish, Game, and Wildlife's Endangered and Nongame Species Program, the FWS New Jersey Field Office conducted a bat survey of the Hibernia Mine in Morris County. A total of 18 endangered Indiana bats (*Myotis sodalis*) were found hibernating at the site. Non-endangered bats also were found: 59 eastern pipistrelles (*Pipistrellus subflavus*), 21 northern long-eared bats (*Myotis septentrionalis*), 5 big brown bats (*Eptesicus fuscus*), and 28,088 little brown bats (*Myotis lucifugus*). The surveyors observed bands on three of the little brown bats. Researchers had banded 2 of the bats in the summer of 1997 within 5 miles (8 kilometers) of the Hibernia Mine while evaluating summer habitat use on and adjacent to the Picatinny Arsenal in Morris County, New Jersey. The third bat was banded the same summer during a research project at the Durham Mine in Quakertown, Pennsylvania.

Reported by Lisa Arroyo of the FWS New Jersey Field Office.

During February and March of 1999, the Fish and Wildlife Service (FWS) published the following proposed and final Endangered Species Act (ESA) listing actions in the *Federal Register*:

Listing Proposals

Mountain Plover (*Charadrius montanus*)

Despite its common name, the mountain plover is not a mountain-dwelling bird but a species of short-grass prairies and shrub-steppe landscapes. Short vegetation, bare ground, and a flat topography are needed by mountain plovers at both their breeding and wintering locales. Extensive changes in these habitats have led to a decline of more than 60 percent in the mountain plover's population since 1966. One factor likely to be responsible for the plover's vulnerable status is the widespread conversion of grasslands to agricultural and urban lands. Another is the decline of prairie dogs, which provide ideal habitat conditions for mountain plovers. Due to the species' vulnerable status, the FWS proposed on February 16 to list the mountain plover as threatened.



Prairie dog
Corel Corp. photo

Bird species endemic to North American grasslands have declined more rapidly than other species in this region, with the mountain plover falling the fastest. The mountain plover breeds in the Rocky Mountain States from Canada to Mexico, primarily in Montana, Colorado, and Wyoming. Most of the birds winter on grasslands or similar habitats in California, although some spend the season in Arizona, Texas, and Mexico.



Mountain plover
Photo by Fritz Knopf/USGS-BRD

Biologists are trying to determine if spring tilling and planting on the drylands of southern Wyoming, eastern Colorado, southwestern Kansas, and northwestern Oklahoma may be contributing to the plover's decline. The possible impacts of pesticide exposure will also be examined. FWS biologists will work with landowners to develop recommendations as to how land uses can be modified, if necessary, to benefit both farmers and mountain plovers. If the species is listed as threatened, it should not have an impact on grazing. In fact, grazing can be beneficial to mountain plovers by maintaining open areas within short-grass habitats; mountain plovers evolved in association with bison and other grazing animals.

Alabama Sturgeon (*Scaphirhynchus suttkusi*)

The Alabama sturgeon, a freshwater fish that historically inhabited some 1,000 miles (1,600 kilometers) of the Mobile River system in Alabama, was once so abundant that it was caught and sold commercially. But today it is among the rarest of North American fish.

The Alabama sturgeon is long and slender, growing to about 30 inches in length, and is a golden-yellow color. A mature fish weighs 2-3 pounds. The head is broad and flattened, shovel-like at the snout. Bony plates cover the head, back and sides. The body narrows abruptly to the rear to form a narrow stalk between body and tail. The upper lobe of the tail fin is elongated and ends in a long filament.

Within the Mobile River system, the Alabama sturgeon inhabited the Black Warrior, Tombigbee, Alabama, Coosa, Tallapoosa, Mobile, Tensaw, and Cahaba

ivers, as well as stretches of the Tombigbee River in Mississippi. It has disappeared, however, from approximately 85 percent of its historic range in the Alabama and Tombigbee rivers and their major tributaries in Mississippi and Alabama. Since 1985, all confirmed captures have been restricted to a short, free-flowing reach of the Alabama River in Clarke, Monroe, and Wilcox counties, Alabama.

During the past 2 years, FWS biologists have worked with the Alabama Department of Conservation and Natural Resources, the Alabama-Tombigbee Rivers Coalition (a group of private businesses and industries with economic interests in these rivers), and other partners on efforts aimed at increasing the numbers of Alabama sturgeon. As a part of these efforts, the Marion State Fish Hatchery has been modified to maintain and propagate Alabama sturgeon, and efforts to collect brood stock have been initiated. Biologists also are seeking to identify important habitats for the species in the Alabama River and to develop strategies for protection and management.

The decline of the sturgeon is believed to be due to overfishing, the loss and fragmentation of habitat as a result of navigation related development, and degradation of water quality. Today, the species' population has been reduced to the point where, if no conservation measures are taken, its chances for recovery are slim. The numbers of surviving sturgeon may be too low for natural reproduction to restore a sustainable population in the wild.

The FWS originally proposed the Alabama sturgeon for endangered status on June 15, 1993. Because of a lack of proof that the species still existed, the proposal was withdrawn on December 15, 1994. Since then, however, six fish have been caught by State, Federal, and commercial and recreational fishermen, events that confirm its continued existence.

The FWS and U.S. Army Corps of Engineers have examined river activities and potential conflicts that might arise from listing the Alabama sturgeon. This study resulted in a joint determination that current activities in the Alabama and Tombigbee rivers, including the annual navigation channel maintenance dredging programs, will have no impact on the sturgeon and will not need to be eliminated or modified should the species be listed. Both waterways already



Alabama sturgeon

Photo by Dr. Elise Irwin/NBS

contain habitat for four listed mussel and fish species, and their presence has not resulted in any use restrictions on the Alabama and Tombigbee rivers.

Delisting Proposals

Tinian Monarch (*Monarcha takatsukasae*)

This creature is not true royalty or a butterfly but a small forest bird endemic to the island of Tinian in the Mariana archipelago of the western Pacific Ocean. It was listed in 1970 as endangered because its population was believed to be critically low due to the destruction of native forests by pre-World War II agricultural development and military action during the war. Based on forest bird surveys conducted in 1982, which resulted in a population estimate of 40,000 monarchs, the FWS reclassified this species in 1987 to the less critical category of threatened. A 1996 survey indicated a population gain to about 53,000 monarchs and noted significant reforestation. Most of the forest renewal has occurred on land managed and



Tinian monarch

Photo by Jaan Kaimanu Lepson

protected by the U.S. Navy under a long-term lease. Because of the recovery of this bird and its habitat, the FWS proposed on February 22, 1999, to remove the Tinian monarch from the list of threatened and endangered species.

Final Listing Rules

Sacramento Splittail (*Pogonichthys macrolepidotus*)

A fish found only in California's Sacramento-San Joaquin Delta and Central Valley rivers, the Sacramento splittail is a silvery-gold member of the minnow family that can grow up to 16 inches (40 centimeters) in length. Its upper tail is enlarged and appears to be split, giving the fish its common name. Historically, it occurred in the Sacramento River as far north as Redding and in the San Joaquin River almost as far south as Fresno. This fish has declined by 62 percent over the past 15 years due to water diversions, periodic prolonged droughts, loss of shallow water breeding habitats, introduced aquatic species, and agricultural and industrial pollutants. Because of the Sacramento splittail's vulnerable status, the FWS proposed on February 8 to list it as threatened.

Catesbaea melanocarpa This rare Caribbean plant, which has no common name, is a small, spiny shrub in the family Rubiaceae. It has been reported from Barbuda, Antigua, and Guadeloupe of the Lesser Antilles and, in the U.S., from Puerto Rico and St. Croix (U.S. Virgin Islands). Much of its preferred dry forest habitat on these islands has been eliminated by agricultural and urban development. Due to the threats posed by continuing habitat loss, the FWS listed *C. melanocarpa* on March 17 as endangered.

The Internet is a great source of information on the activities of zoos and other institutions to recover endangered species. Here are some sites to get you started:

The U.S. Fish and Wildlife Service's Endangered Species Recovery and Delisting Program has a website with information on cooperative efforts with zoos: <http://fws.gov/r9endspp/recovery/partner3.htm>

You can reach the American Zoo and Aquarium Association (AZA) at <http://www.aza.org>

AZA institutions mentioned in this edition of the *Bulletin* include:

The Phoenix Zoo (Phoenix, Arizona)
<http://www.phoenixzoo.org/>

Knoxville Zoo (Knoxville, Kentucky)
<http://www.knoxville-zoo.com/>

Louisville Zoo, (Louisville Kentucky)
<http://www.iglou.com/louzoo/>

John Ball Zoological Garden (Grand Rapids, Michigan)
<http://www.co.kent.mi.us/zoo/>

Toledo Zoological Gardens (Toledo, Ohio)
<http://www.toledozoo.org/>

Roger Williams Park Zoo (Providence, Rhode Island)
<http://users.ids.net/~rwpz/>

Tennessee Aquarium (Chattanooga, Tennessee)
<http://www.tennis.org/>

The Metro Toronto Zoo (Ontario, Canada)
<http://www.torontozoo.com/>

BOX SCORE

Listings and Recovery Plans as of June 30, 1999

GROUP	ENDANGERED		THREATENED		TOTAL LISTINGS	U.S. SPECIES W/ PLANS**
	U.S.	FOREIGN	U.S.	FOREIGN		
 MAMMALS	61	251	8	16	336	48
 BIRDS	75	178	15	6	274	77
 REPTILES	14	65	21	14	114	30
 AMPHIBIANS	9	8	8	1	26	11
 FISHES	69	11	41	0	121	88
 SNAILS	18	1	10	0	29	20
 CLAMS	61	2	8	0	71	45
 CRUSTACEANS	17	0	3	0	20	12
 INSECTS	28	4	9	0	41	27
 ARACHNIDS	5	0	0	0	5	5
ANIMAL SUBTOTAL	357	520	123	37	1,037	363
 FLOWERING PLANTS	540	1	135	0	676	494
 CONIFERS	2	0	1	2	5	2
 FERNS AND OTHERS	26	0	2	0	28	26
PLANT SUBTOTAL	568	1	138	2	709	522
GRAND TOTAL	925	521	261	39	1,746*	885

TOTAL U.S. ENDANGERED: 925 (357 animals, 568 plants)
TOTAL U.S. THREATENED: 261 (123 animals, 138 plants)
TOTAL U.S. LISTED: 1186 (480 animals***, 706 plants)

*Separate populations of a species listed both as Endangered and Threatened are tallied once, for the endangered population only. Those species are the argali, chimpanzee, leopard, Stellar sea lion, gray wolf, piping plover, roseate tern, green sea turtle, saltwater crocodile, and olive ridley sea turtle. For the

purposes of the Endangered Species Act, the term "species" can mean a species, subspecies, or distinct vertebrate population. Several entries also represent entire genera or even families.

**There are 519 approved recovery plans. Some recovery plans cover more than one species, and a few species have separate plans covering different parts of their ranges. Recovery plans are drawn up only for listed species that occur in the United States.

***Nine animal species have dual status in the U.S.

ENDANGERED Species BULLETIN

*U.S. Department of the Interior
Fish and Wildlife Service
Washington, D.C. 20240*

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